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Analysis of the possibilities of using “Light Freight Railway” for the freight transport implementation in agglomeration areas (example of West Pomerania Province)

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Abstract

The article presents the concept of using self-propelled railway sets, as a system to increase the share of rail transport in total freight transport. The area taken into considerations is the West Pomerania Province, including in particular the Szczecin Metropolitan Area.

Considerations taken in the article arise directly from the author's previous publications, including the developed feasibility study on the opening of the passenger rail network (Szczecin Metropolitan Railway) on the designated area, fully integrated with other forms of passenger transport - organized and individual. Modernization of the railway infrastructure assumed in the study may also constitute the potential for the future development of rail freight transport in the region - in the form of the “Light Freight Railway”.

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Keywords: transport, rail transport, freight transport, urban logistics, transportation, Light Freight Railway, agglomeration transportation services

1. Introduction

Rail transport is one of the land branches. Its essential feature is a permanent link between the means of transport and infrastructure. Travelling only on the specially designed and built rail way - called railway track (Karbowiak, 2009), determines certain features affecting its functioning. These include e.g.:

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- the ability to transport a single large mass load (infrastructure dedicated exclusively to the rail allows for the use of high pressure on the rail (Bogdaniuk and Massel, 1999), also the formation of even several meter-long sets),
- ensuring a high level of transport safety (determined by e.g. multistage traffic management and infrastructure division into smaller sections designed only for one train at one time),
- low level of vulnerability to adverse weather conditions,
- independence from congestion occurring in the road transport,
- low level of occupancy of the land line infrastructure (it is estimated that to achieve similar capacity it is required to have two-lane highway with a width of 29 m or double track railway line with a width of 13.7 m) (Engelhardt and Wardacki and Zalewski, 1995).

This permanent link between the means of transport and infrastructure also entails adverse consequences for the railway, which may include e.g.:

- limited ability to perform "door to door" railway connections (there is a small number of senders and recipients with railway sidings); limited ability of direct deliveries usually results in the need to involve other branches into the transport, which increases the number of transshipments and extends the time of transport,
- full dependence on the availability of infrastructure - lack of use of substitute or temporary infrastructure, or using roads of other branches,
- inability to avoid obstacles located on the track (in emergencies there is the need to use bypass tracks of often distant lines).

Permanent link between rolling stock and infrastructure significantly makes the functioning of this branch of the transport dependent on infrastructure. Unevenly developed railway network in various European countries, as well as the lack of full technical interoperability (the track width, voltage, management and traffic control systems) between countries, significantly impedes the development of railways and its competitiveness towards other modes of transport.

What is extremely important, the operation of rail transport is also dependent on transport policy of the state and adopted principles of financing, construction and maintenance of individual branches. Rail transport is characterized by high sensitivity in this area. Prolonged inactivity of the state in the field of modernization and the consequent negligence cause degradation of infrastructure. This has a negative impact on the operation of the railway and its activation (Pietrzak, 2014) by reducing the speed and safety of rail services, and as a result reduction in the competitiveness of this sector in relation to other. To reverse this unfavorable situation for the rail transport, it is necessary to make urgent implementation of a number of modernization projects at one time. However, conducting "cumulative" repair and modernization works on too large area at one time also has a negative impact on the functioning of this branch, reducing network capacity and affecting the extended time of transport.

2. Rail transport – its place in freight transport

When analyzing the spatial distribution of cargo origins and destinations and the diversity of the cargo size (weight) of individual shippers, it is possible to point to four basic transport relationships:

- (1) from senders of large volumes of cargo to recipients of large volumes of cargo,
- (2) from senders of large volumes of cargo to recipients of small volumes of cargo,
- (3) from senders of small volumes of cargo to recipients of large volumes of cargo,
- (4) from senders of small volumes of cargo to recipients of small volumes of cargo.

Considering the transport services of mentioned relationships performed exclusively by rail transport, it is possible to point to different possibilities, methods and organization of such transport through this branch.

The first of these relationships is characterized by the least complicated process of organization. The transport is performed using only one means of transport, without the need for costly and time-consuming reloading and changes in the means of transport/branches. The transport is characterized by the presence of a large number of homogeneous

cargo volumes, which enables the railway transport to use one of its basic characteristics. Uncomplicated block train transport system (railway services carried out for a single customer using block train composition) (Raport z badania, 2012) in a relationship one supplier - one recipient (direct transport) is the most common way of organizing transport (Zalewski and Siedlecki and Drewnowski, 2005). Thanks to the simplified process of the transport, the railway can offer more favorable freight tariff than other modes of transport.

Another indicated relationships (second and third) concern the relationship between transport services customers with different sending/receiving capacity potential. In this situation, e.g. due to economic reasons, it is not advisable to provide direct trains between senders and recipients. That would mean the rail transport delivery using a small amount of train wagons, and thus the cost of transport would significantly affect the final price of cargo.

The last of the indicated relationship is a network of connections among senders of small volume of cargo and customers with little potential for its reception. This type of transport is also not an optimal solution for rail freight (block train compositions) understood in a traditional way. The volume of cargo available to each of the senders is insufficient to make full use of one of the characteristics of rail transport - its mass character. Implementation of the transport process in the indicated relationship (between one sender and one receiver) using a block train composition, with insufficient flow of cargo, also in this case, would be unjustified from an economic point of view.

In the transport relationships between the sender and the recipient, where it is unjustified to use direct, block train transport, there is used wagon transport (distributed transport). It can be defined as “rail services performed for the benefit of a single sender using individual containers, wagons or groups of wagons - not forming block train compositions” (Raport z badania, 2012). In contrast to the block train transport, the solution of providing individual wagon or small groups of wagon is characterized by increasing complexity of transport process, and thus increasing the cost and the total time required for delivering cargo from the sender to the recipient.

The smooth operation of the distributed rail transport requires the use of nodes, acting as a kind of consolidation/deconsolidation hubs. These nodes perform a double function in the whole system:

- allow for the concentration of cargo flows from various senders and creation of block train compositions between major hubs,
- allow for the stripping block train compositions and distribution of cargo flows between individual recipients.

Operation Chart for indicated relationship using only rail transport (without the participation of other modes of transport) is presented in Fig. 1.

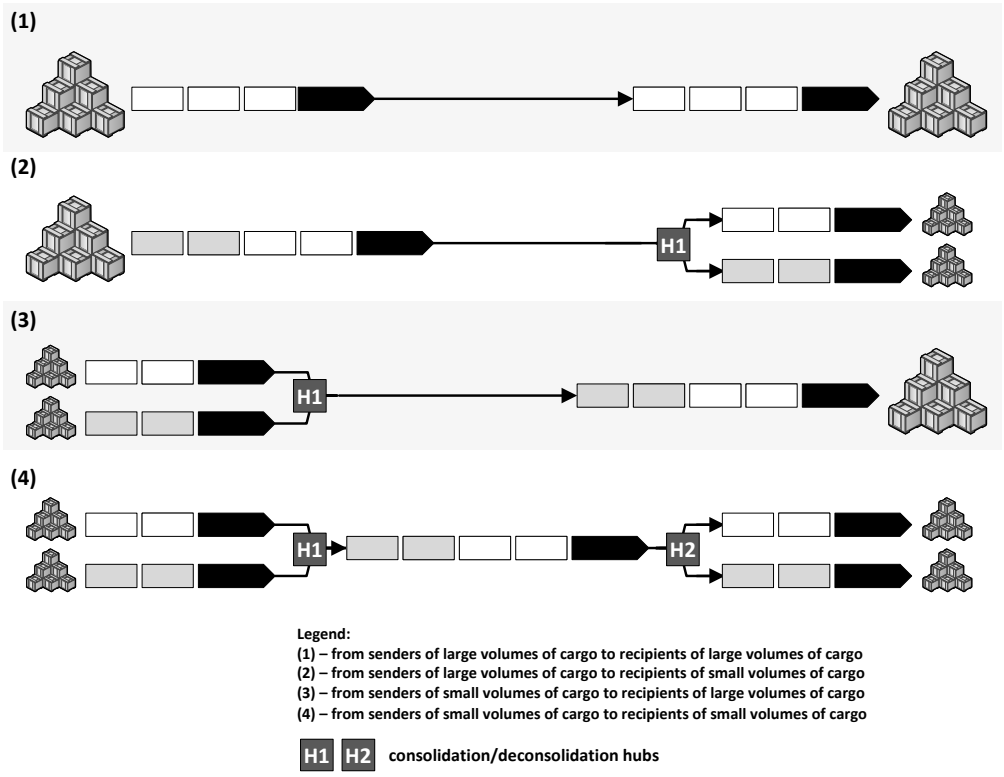

Fig. 1. Diagram of rail transport use for handling selected transport relationships. Source: Pietrzak, 2015.

Economic changes taking place today, affecting among others the freight structure in the transport service market (bulk cargo preferred so far by rail transport give way to unit, valuable loads), significantly influence the development of individual modes of transport. Freight of heterogeneous properties, parts, as well as coming from different senders and recipients occurring on the market limit the use of universal wagons by the railway, or even cause the search for more flexible forms of transport. In this case, the rail loses the battle for customers and their cargo with competitors; due to the need to intensify the organizational and technological work, distributed rail freight transport give way to road transport, providing additional “door to door” opportunity.

3. Methods of using railway in freight transport

As mentioned earlier in the article, the contemporary market environment of transport services has been significantly changed, while also affecting changes in the functioning and role of the different modes of transport. Due to changes in available cargo, rail freight transport is not currently able to use its advantage in the form of bulk transport.

New transport market customer expectations contributed significantly to the verification of the current position and role of each of the modes of transport, emphasizing above all the ability of individual operators to carry out the transport service at the highest level. This resulted in the increased role of road transport – which is flexible and provides delivery with a high degree of timeliness. Moreover, because of the extensive network infrastructure, it also operates in “door to door” system. Rail operators are therefore forced to redesign business profile completely, including: the organization of transport, owned rolling stock and the use of modern information and communication technologies in order to significantly increase its participation in the total transport.

Introducing changes in the functioning of the rail operators and increasing the competitiveness of railway in relation to road transport requires the active participation of the state, which in addition to providing the necessary infrastructure, will act as a catalyst, affecting the development of railways by creating the right legislative conditions on the transport services market. In the Polish case, the main directions of the future development of rail freight are presented in the document "Transport Development Strategy to 2020 (with the prospect of 2030)". According to the document, the primary role of railways in the transport market is operating in the segment of block train and intermodal transport. The future role of the rail is primarily to provide services complementary to other sectors in order to jointly offer customers a complete and modern transport service. The author, however, indicates no other alternative forms of development of rail transport. Transport market is still evolving. Therefore, it is worth to consider other options that also affect the stimulation of rail transport to increase its share in the total transport.

In terms of freight handling capabilities indicated in Fig. 1 only by rail, it is worth paying attention to the concept of self-propelled train compositions for the transport of containers. The idea of such trains is a combination of several wagons (platforms), of which the wagon cars at both ends in the composition are equipped with control cabin and internal combustion engines. Diagram of the means of transport used in the indicated solution is presented in Fig. 2. Due to its characteristics, this composition is often referred to in the literature as the push-pull freight train (Stokłosa and Cisowski, 2012). Its construction (cabin located on the two sides of composition) allows to handle transshipment points in shuttle mode, without unnecessary, time-consuming maneuvers and the need to switch locomotives from one end to the other.

Figure 2. Diagram of a self-propelled train composition for containers. Source: Stokłosa, 2011.

Such a train system, called in the literature as "truck on the tracks" (Kuhla, 2001) was tested by German railways under its own brand "Cargo Sprinter" in the 90-ies of 20th century. The system was based on the technology of connecting many individual self-propelled compositions from smaller terminals at junctions and forming them into a quasi block train composition. Then, the composition was separated when reaching the next junction and finally it was separated at the individual dedicated unloading terminal.

After a period of testing, the German railways ceased to use this solution. Self-propelled compositions were designed mainly as an alternative for road transport - their lightweight construction, on the one hand, allowed for the minimization of fuel consumption, on the other hand, made it difficult to combine them into block train compositions. This case would also mean non-standard planning of routes for this type of composition on the railway network; here also appear important features similar to road transport. Organization of transport of multiple Cargo Sprinter compositions on the whole route from the sender to the recipient (often at considerable distances) would entail the need to search for other orders in the vicinity of the unloading terminal, or return without any freight to the place of origin.

When analyzing the Sprinter Cargo system, it shall be remembered that it was tested in the period of clarification of ideas on the liberalization of the railway market and measures aimed at increasing its efficiency and competitiveness within the European Union. In this period (Directive 91/440/EEC, 95/18/EC, 95/19/EC, 96/48/EC) European countries reached only a certain consensus on the framework of reforms introduced to the market, as well as rules for their implementation.

According to the author, today - at a time when the European Union introduces a wider and wider range of measures to stimulate rail transport to be active competitor in the transport market, it seems noteworthy to re-examine the possibility of using the system indicated. This time, however, not as an alternative to the traditional freight train, but a substitute for road transport, capable of providing transport to and from transport hubs. Nowadays, Cargo Sprinter solution could make rail freight a more competitive and attractive option for shippers, receivers and operators in the field of feeder services, city logistics and logistics centres (Bozicnik, 2006).

The principles of the proposed solution, using self-propelled train compositions compared to traditional solutions: block train composition and mainline train, are shown schematically in Fig. 3.

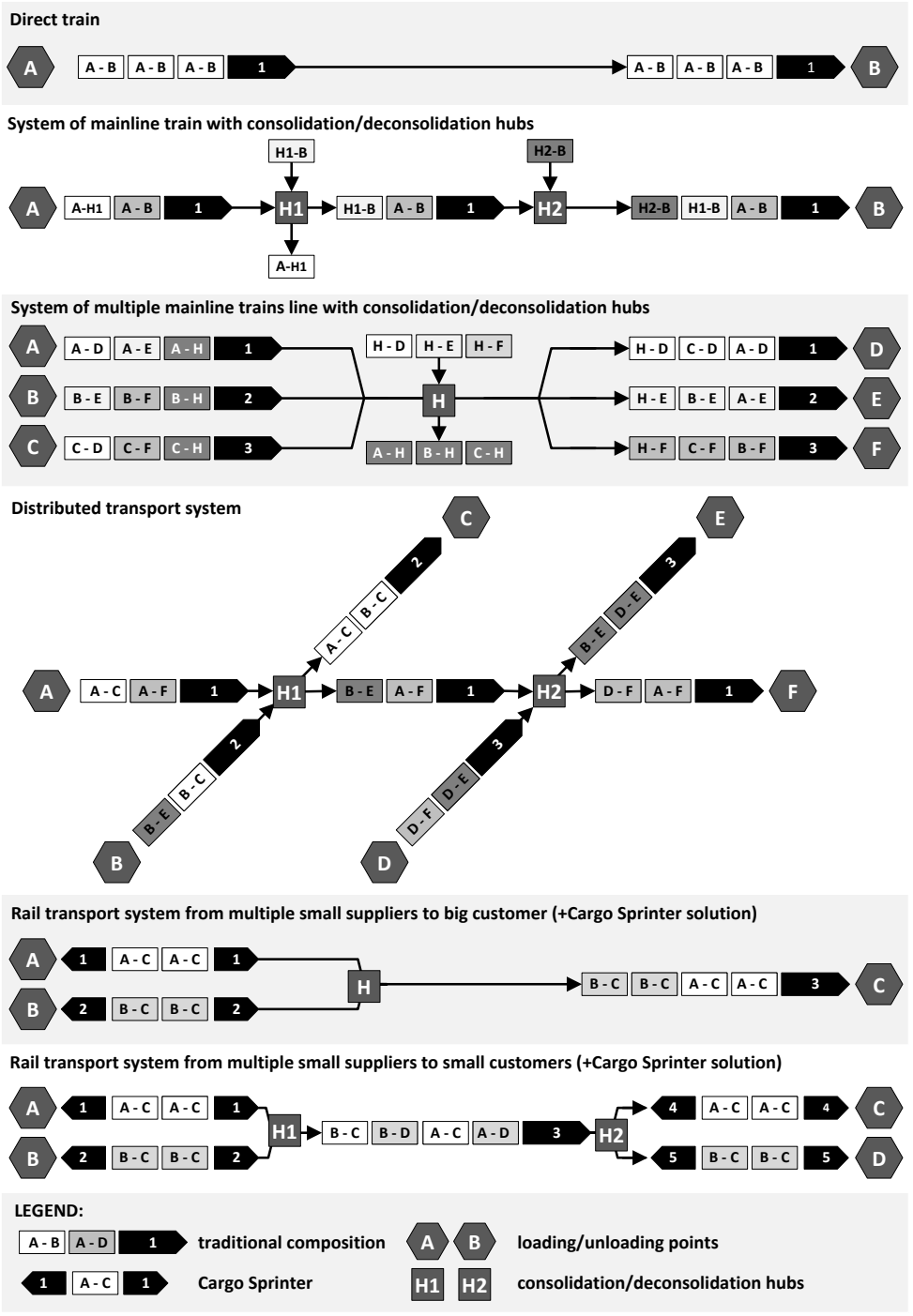

Fig. 3. Selected methods of handling freight rail transport. Source: Pietrzak 2015.

4. Freight railway transport in West Pomerania Province

The concept of using “Light Freight Railway” in the freight transport in the area of West Pomerania Province is the consequence of previous work of the author in the study "Concept of the Szczecin Metropolitan Railway” (Pietrzak, 2014) and the "Feasibility study of the Szczecin Metropolitan Railway” (Pietrzak and Pietrzak, 2015). Szczecin Metropolitan Railway is a project designed to create the network of coordinated, fully integrated with other modes of transport (collective and individual) passenger rail connections in the Szczecin Metropolitan Area, which are to be the main axis of public transport in the region in the future. The project involves the operation of Szczecin Metropolitan Railway based on the existing infrastructure, with its substantial part not being currently used to provide passenger transport (mainly due to the poor technical condition). The project involves the modernization of the network with the construction of a second track on the single-track sections, as well as the installation of modern traffic control devices – which ultimately will increase the speed of trains and greatly increase network capacity.

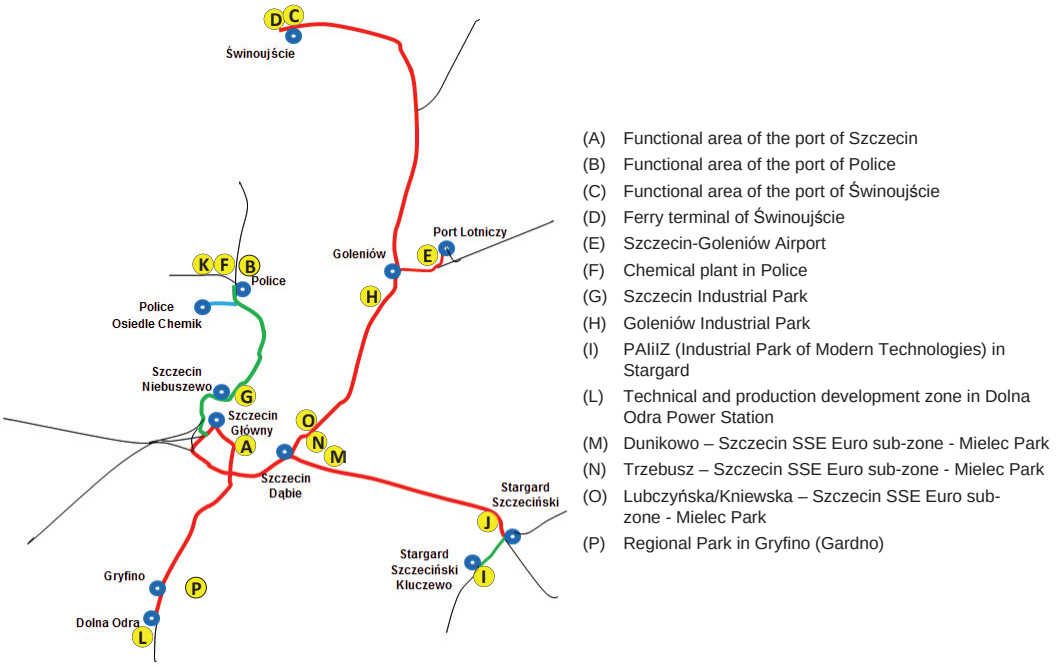

Fig. 4. Selected zones of economic and industrial activity in the Szczecin Metropolitan Area Association within the planned Szczecin Metropolitan Railway network. Source: Pietrzak, Pietrzak 2015.

In addition to “traditional” points generating passenger traffic of the Szczecin Metropolitan Railway, i.e. city centers, centers of education, science, health, sport and recreation, the planned Szczecin Metropolitan Railway network shall also cover numerous industrial and business areas, including special economic zones gathering various business activities (Fig. 4). These points, in addition to generating passenger traffic, naturally create a potential in terms of freight traffic. A large part of them has dedicated rail siding, capable of handling rail freight transport.

Specific feature of large part of the selected areas, including in particular the special economic zones, is the functioning of a number of entities with different business profile at one area. However, they do not have sufficient sending/receiving potential. Therefore, it is not economically justified to provide block train transport for these areas. According to the nomenclature adopted in Figure 1, business operating in these areas can be considered “senders of small volumes of cargo” or “recipients of small volumes of cargo”. Thus, it would be justified to handle this transport by rail transport with a much lower transport potential than traditional block train composition. A characteristic feature

of self-propelled railway system in relation to the "traditional" forms of transport carried out by the railway is its much lower weight. It may, therefore, provide transport on local lines in poor condition and limited permissible axle load.

The concept of handling these entities through self-propelled railway systems, on the one hand, would allow to meet their transportation needs, on the other hand, would affect the possibility of a gradual reduction of the role of road transport in this area. In the entire metropolitan area, this could mean a reduction in road freight traffic in its center urban areas (Szczecin, Goleniów, Stargard, Police, Świnoujście, Gryfino), which ultimately could result in lowering congestion and improving safety, including reducing fatal accidents.

According to the adopted concept, self-propelled train compositions could serve as a mode to transport cargo from and to points with a low potential for generating flows of cargo, allowing for connection of these points with the regional rail consolidation/deconsolidation hub. In these hubs, cargo separated into units could be formed in the block train compositions travelling to identical hubs in other regions of the country/Europe. Then, they would be further separated and delivered to shipping points using road transport, or a self-propelled train composition (if the regional hub would be supported by such a solution). This solution is shown schematically in Fig. 5.

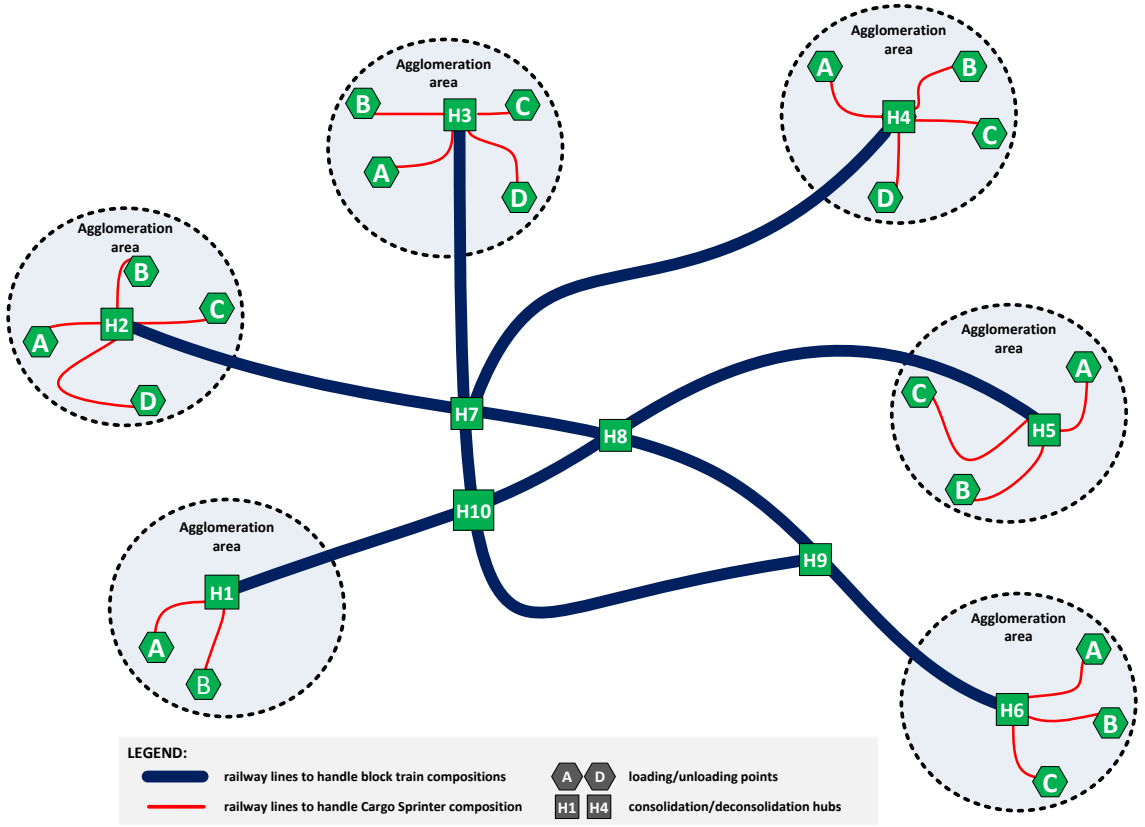

Figure 5. The concept of using self-propelled railway Cargo Sprinter compositions to handle rail freight transport between agglomerations. Source: Own study.

The implementation of the concept could lead ultimately to a reduction in the share of road transport in the intermodal system, where it is used for transporting freight from and to the certain points, or a complete change of branches providing transport services – from the road transport (in "door to door" system) for the benefit of handling the whole transport process by rail transport (with an acceptable option to change the means of transport without changing the branch).

According to the concept of self-propelled train compositions, they would be used, as opposed to the model functioning as Sprinter Cargo in Germany, only in the particular region, without the need for long travel, and thus preclude the necessity of planning a complicated train routes and the search for their return cargo. On the other hand, the need for transshipment in consolidation/deconsolidation hubs causes longer time of providing transport services. Therefore, to minimize this risk it would be necessary to develop effective forms of transshipment in the hubs and to use modern ICT tools.

Conclusion

Due to economic changes, structure of cargo unfavorable for the railway, limited role of bulk cargo, as well as changing customer preferences, the railway is not able to use its existing competitive advantage in the form of bulk transport. Unit cargo and LCL goods, often of considerable value, displace traditional, simplified modes of transport. Their heterogeneity in terms of quantity, properties and place of origin and destination, affects the need to apply more flexible transport solutions.

Modern rail freight transport faces a difficult task to adapt its offer to the market, which involves, among others, the modernization of rolling stock, devices and handling techniques, the introduction of a wider use of ICT tools, as well as industry promotion.

When creating a new quality of the rail transport and increasing its competitiveness in relation to other branches extremely important becomes the role of the state acting on the market as the entity managing and modernizing infrastructure, as well as deciding on the access fees. A significant area for the development of rail transport is the policy of the European Union, which should be more decided, when supporting the industries and transport solutions that contribute to reducing the negative socio-economic effects of the impact of transport on the environment.

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